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Hemosporids (Apicomplexa, Hematozoea, Hemosporida) of Anatids from the Southern High Plains of Texas

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ABSTRACT: The structure and pattern of the hemosporid community of wintering waterfowl were examined based on thin blood smears collected from 43 cinnamon teal (*Anas cyanoptera*), 89 green-winged teal (*Anas crecca*), and 64 American wigeon (*Anas americana*) on the Southern High Plains of Texas. Thirty-two ducks (16%) were infected with *Haemoproteus nettionis, Haemoproteus greineri, Plasmodium circumflexum, Leucocytozoon simondi,* and/or microfilariae. Intensities of *H. nettionis, H. greineri,* and *P. circumflexum* ranged from <1 to 7, <1 to 28, and 1 to 28/10,000 erythrocytes, respectively. Mean intensities of *H. nettionis, H. greineri,* and *P. circumflexum* were 3.2 ± 0.8 (SE), 5.3 ± 3.0, and 6.4 ± 3.6/10,000 erythrocytes, respectively. Abundances for *H. nettionis, H. greineri,* and *P. circumflexum* were 0.2 ± 0.1, 0.2 ± 0.2, and 0.2 ± 0.2/10,000 erythrocytes, respectively. The low abundance values seemed to preclude any species interactions at the component level in this hemosporid community during the latent period. *Haemoproteus nettionis* from a cinnamon teal and *H. greineri* from American wigeon are new host records.

KEY WORDS: hemosporids, *Haemoproteus greineri, Haemoproteus nettionis, Leucocytozoon simondi, Plasmodium circumflexum,* microfilaria, ducks, *Anas* spp., American wigeon, cinnamon teal, green-winged teal.

Factors affecting survival and recruitment of waterfowl include morbidity and mortality from hemosporid blood parasites (Fallis and Bennett, 1966; Herman et al., 1975; Desser and Ryckman, 1976). Thus, waterfowl have been surveyed for Hemosporida in many breeding areas in North America (Bennett et al., 1975, 1982; Williams et al., 1977). However, there are few studies on these parasites in wintering waterfowl (Polcyn and Johnson, 1968; Kocan et al., 1979; Loven et al., 1980).

The winter period is important because it may represent unique stresses for waterfowl (Alford and Bolen, 1977; Bennett and Bolen, 1978; Jorde et al., 1984); the additional stress of parasitemia could have a synergistic effect on survivability. Infected individuals that survive over winter and return to the breeding grounds are responsible for the perpetuation of the hemosporid vector–host cycle. Also, the migratory ability of waterfowl has particular implications for maintaining and potentially dispersing parasites between summer and winter ranges as well as along migration routes.

There is little quantitative information concerning hemosporid community structure (composition, intensity, and abundance) and pattern (prevalence and species richness) across the latent period of the hemosporid cycle because most studies represent point prevalence data that fail to demonstrate host-related patterns in hemosporid abundance (Godfrey et al., 1987). We examined the structure and pattern of intraerythrocytic hemosporid assemblages during the winter in American wigeon (*Anas americana*), green-winged teal (*Anas crecca*), and cinnamon teal (*Anas cyanoptera*) on the Southern High Plains of Texas.

Materials and Methods

Ducks were trapped at 2 sites on the Southern High Plains in Castro (34°23′N, 102°22′W) and Parmer (34°28′N, 102°55′W) counties, Texas, from October 1985 to March 1986. Blood was drawn via brachial vein puncture with a sterile lancet. Two thin blood smears were made from each bird. Each bird was banded and released.

Blood smears were fixed in methanol and stained with Diff-Quick® (Dade Diagnostics, Inc., Aguada, Puerto Rico 00602). All blood smears were examined and Hemosporida species identified and counted using the same microscope by the same observer (A.M.F.).

To determine prevalence, both blood smears were examined for 30 min for cinnamon teal and 20 min for wigeon and green-winged teal at ×1,000 magnification. A methodology has not been developed for quantifying microfilariae on thin blood smears or for quantifying hemosporids, which occur in both erythrocytes and leucocytes (*Leucocytozoon* spp.); these are reported herein only as prevalence data. Quantification of intraerythrocyte hemosporids generally followed the recommendations of Godfrey et al. (1987). Ten thousand erythrocytes were counted and examined in 100

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Table 1. Prevalence (%) of hemosporids identified from 3 species of waterfowl on the Southern High Plains of Texas from October to March 1985–1986.

Duck species	N*	*Haemoproteus nettionis*	*Haemoproteus greineri*	*Plasmodium circumflexum*	*Plasmodium* sp.	*Leucocytozoon simondi*	Microfilaria
Cinnamon teal	43	1 (2)	0 (0)	0 (0)	0	0 (0)	0 (0)
Green-winged teal	89	8 (9)	7 (8)	5 (6)	0	6 (7)	4 (4)
American wigeon	64	1 (2)	2 (3)	2 (3)	1 (2)	3 (5)	1 (2)
Total	196	10 (5)	9 (5)	7 (4)	1 (<1)	9 (5)	5 (3)

* Number of host individuals examined.

replicates of 100 erythrocytes each to provide an estimate of intraerythrocyte parasite intensity within each infected host. Counts of 10,000 erythrocytes were chosen to assure that at least >90% of infected hosts would have hemosporid intensities ≥1/10,000 erythrocytes based on the apparent intensities observed while examining the smears for prevalence.

Parasites were identified following descriptions of Garnham (1966), Williams and Bennett (1980), and Bennett et al. (1984). Identifications were confirmed by G. F. Bennett (International Centre for Avian Haematozoa, Memorial University of Newfoundland, St. John's Newfoundland, Canada A1C 5S7). Representative specimens are deposited in the International Centre for Avian Haematozoa (accession Nos. 98432 and 103691–103695).

Definitions for the terms prevalence, intensity, and abundance follow those of Godfrey et al. (1990) as modified from Margolis et al. (1982). Intensity and abundance data are presented as mean number of hemosporid individuals ± 1 SE/10,000 erythrocytes.

Results

Thin blood smears were examined from 43 cinnamon teal, 89 green-winged teal, and 64 American wigeon (Table 1). Low prevalences (≤9%) of hemosporid species precluded statistical analysis using prevalence, intensity, and abundance data to examine host-intrinsic (interspecies comparisons; intraspecies age and sex class comparisons) variables.

Thirty-two ducks (16%) were infected with *Haemoproteus nettionis, Haemoproteus greineri, Plasmodium circumflexum, Plasmodium* sp., *Leucocytozoon simondi,* and/or microfilariae. Twenty-seven percent of the green-winged teal were infected; only 9% of wigeon and 2% of cinnamon teal were infected. Ten, 9, 7, 9, and 5 ducks were infected with *H. nettionis, H. greineri, P. circumflexum, L. simondi,* and microfilariae, respectively. A *Plasmodium* sp. from one wigeon was only tentatively identified as *P.* (*Novyella*) *vaughani* (G. F. Bennett, pers. comm.). In 5 green-winged teal, 2 were infected with *P. circumflexum* and *L. simondi,* 2 with *H. nettionis* and *H. greineri,* and 1 with *H. nettionis, H. greineri,* and a microfilaria. In 2 wigeon, 1 was infected with *P. circumflexum* and *L. simondi* and 1 with *H. nettionis, H. greineri, L. simondi,* and a microfilaria.

Intensities of *H. nettionis, H. greineri,* and *P. circumflexum* ranged from <1 to 7, <1 to 28, and 1 to 28/10,000 erythrocytes, respectively. Mean intensity and abundance values for *H. nettionis, H. greineri,* and *P. circumflexum* are presented in Table 2. *Haemoproteus greineri* from American wigeon and *H. nettionis* from cinnamon teal are reported for the first time from these hosts, respectively.

Discussion

Models depicting circulation of hemosporids during the latent period show relatively low prevalences (Beaudoin et al., 1971) and intensities (Herman, 1968). Although there are no other intensity (abundance) data for hemosporids from wild waterfowl during winter, our results demonstrate that extremely low hemosporid intensities occur in the peripheral blood during the latent period. Chernin (1952) described this phenomenon in domestic ducks; he suggested that the observation of immature *L. simondi* during winter was the result of at least some schizogony occurring during this period.

Low intensities of hemosporids circulating in the peripheral blood reduce the probability of transmission on the wintering grounds. This may represent an adaptive strategy of hemosporids utilizing hosts in temperate regions as a way of conserving infective stages when vectors are not available (Allan and Mahrt, 1989; Greiner, 1991). Relapse typically occurs in late spring or summer coinciding with the emergence of vectors and an abundance of breeding ducks; this helps per-

Table 2. Intensity and abundance of hemosporids from 3 species of waterfowl on the Southern High Plains of Texas from October to March 1985–1986.

	Intensity			Abundance		
Duck species	*Haemoproteus nettionis*	*Haemoproteus greineri*	*Plasmodium circumflexum*	*Haemoproteus nettionis*	*Haemoproteus greineri*	*Plasmodium circumflexum*
Cinnamon teal	3.0 ± 0.0*	–†	–	0.1 ± 0.1	–	–
Green-winged teal	2.7 ± 0.8	6.0 ± 3.9	8.0 ± 5.1	0.2 ± 0.1	0.5 ± 0.3	0.4 ± 0.3
American wigeon	7.0 ± 0.0	3.0 ± 2.0	2.5 ± 1.5	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Total	3.2 ± 0.8	5.3 ± 3.0	6.4 ± 3.6	0.2 ± 0.1	0.2 ± 0.2	0.2 ± 0.2

* Mean ± standard error of intraerythrocytic hemosporids/10,000 erythrocytes.
† 0/43 infected.

petuate the infection–reinfection cycle as well as producing a large pool of immunologically unchallenged ducklings. Our data support this hypothesis.

Abundance values of hemosporids during the latent period are so low that few, if any, species interactions seem probable at the component community level (as defined by Bush and Holmes, 1986). Indeed, the community ecology of the several potentially interactive hemosporid species in ducks during the spring relapse period needs to be more critically studied in terms of host, temporal, and spatial factors affecting parasite abundances. Only one previous study (Godfrey et al., 1990) has shown the effect of host and spatial factors in *Haemoproteus* spp. representing a hemosporid community in mourning doves (*Zenaida macroura*).

We found *H. greineri* in wigeon and green-winged teal; this species has not been reported previously in wintering waterfowl. Bennett et al. (1984) believed that *H. greineri* may be endemic to northern portions of the Canadian prairie provinces. This suggests that some green-winged teal and wigeon wintering or migrating through the Southern High Plains are from this region.

Herman (1951) found only 1 of 71 cinnamon teal infected with a *Plasmodium* sp. We found *H. nettionis* in 1 of 43 cinnamon teal. Perhaps these ducks are refractory to hemosporids or breed in areas with low vector densities.

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